

**IMPROVING COGNITIVE INDEPENDENCE OF
DEMENTIA PATIENTS USING MACHINE LEARNING
ENABLED MOBILE
APPLICATION.**

Project Id: TMP-2023-081

Project Proposal Report

Hiththatiyage D.K

B.Sc. (Hons) Degree in Information Technology

Department of Computer Science and Software Engineering

Sri Lanka Institute of Information Technology

Sri Lanka

March 2023

**IMPROVING COGNITIVE INDEPENDENCE OF
DEMENTIA PATIENTS BY DIRECTING THEM TO THE
APPROPRIATE MUSIC THERAPY SESSIONS WHILE
ANALYZING THEIR EMOTIONAL STATE**

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A declaration, copyright statement, and the statement of the supervisor.

We declare that this is our work, and this proposal does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any other university or institute of higher learning, and to the best of our knowledge and belief, it does not contain any material previously published or written by another person except where the acknowledgment is made in the text.

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Abstract

Dementia patients are individuals who have a decline in their cognitive and memory abilities that interferes with their daily life and activities. It is a progressive condition that affects thinking, memory, behavior, and the ability to perform everyday activities. Even though finding a cure for dementia like debilitating condition is a priority researchers have now identified the need to provide a better quality of life and care for these patients. Most of the research's state that these patients are in need of a third-party care to carry on with their day-to-day life. This might be a hectic procedure for the patient as well as these third-party members. So, in order to overcome that we are implementing a solution to improve the quality of life and independence of these patients. Here we mainly consider the mild and the moderate party of this patients. People with dementia lose awareness of their emotional state, which changes periodically without the patient's knowledge. Therefore, the majority of experts in the sector advise musical therapy to keep patients emotional states stable. It has been discovered that a person's personality and mood swings are closely tied to music. And the part of the brain that affects emotional stability is where the timber, pitch, and meter are managed. Keeping the aforementioned considerations in mind, as well as the need to improve these patients' quality of life, this research study will discuss the implementation of an emotional-based personalized music player designed with dementia patients in mind.

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1. Introduction

1.1. Background & Literature survey

Dementia patients are individuals who have a decline in their cognitive and memory abilities that interferes with their daily life and activities. It is a progressive condition that affects thinking, memory, behavior, and the ability to perform everyday activities. The number of elderly persons and life expectancy are both rising as a result of developments in medicine and technology. It is anticipated that every 20 years, the number of people living with Alzheimer's disease will nearly double [1].

The family has to take on the role of primary caregiver, which is frequently an emotionally challenging job. Family caregivers made up around one-third of those who showed symptoms of depression. Initially, it can be quite difficult for distant caregivers to continuously monitor patients as not everyone is living closer by [2]. It has been demonstrated that engaging in activities improves quality of life for those who have dementia, some activities may become impossible due to the disease's symptoms. In most circumstances their only option is to depend on a third party to carry on with these activities. However, finding accessible activities and devices to improve the quality of life of these patients can be difficult for family members and caregivers, which will be examined more in this study.

Usage of touch displays has been found to be successful for dementia patients and is gaining attraction. There is a physical link between the user and the display, and when individuals touch the screen, they immediately receive feedback [3]. One of the most important and difficult tasks in developing such applications is creating a user interface that is suitable for individuals who are suffering from Dementia. Today, mobile devices have become the standards for the implementation of assistive technologies to help people with physical and cognitive disabilities. The user experience for these apps have to be straightforward and uncomplicated, with larger fonts and clearly labeled, large buttons. The GUI needs to be adjusted for older users with poor vision. It shouldn't rely on the user having solid motor abilities as well. To the greatest extent possible, colors should be employed to further separate the various purposes of a button or region [4].

Recent studies indicate, people with dementia can experience and enjoy music even in their latter stages of the disease [3]. To enhance cognitive performance, there are two methods: pharmaceutical and non-pharmacological interventions. People with dementia still preserve their musical ability. Hence, one of the main strategies of the non-pharmacological intervention approach is music-based intervention [4]. Even though there are benefits associated with offering musical activities, caregivers lack the tools and sometimes the expertise to assist the patient in selecting music in accordance with preference or mood.

According to the referred information, a digital assistant is mandatory for cognitive disabled individuals to improve their quality of life and independence with the help of music (Figure 1.1). This assistant will guide these people to necessary music sessions in accordance with those emotions.

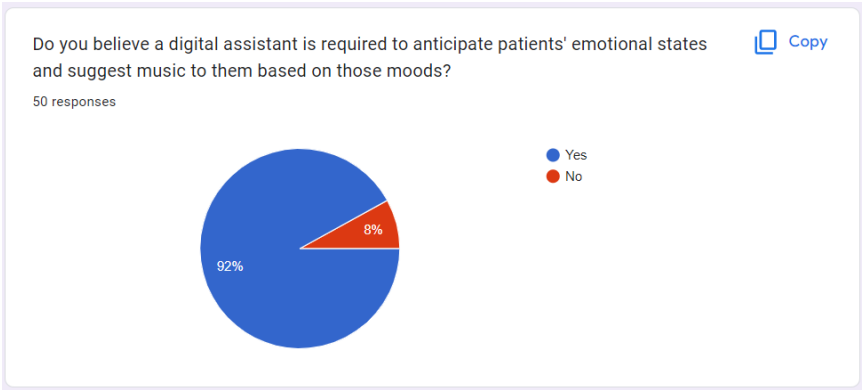


Figure 1.1 – Survey results on the importance of digital assistant for musical therapy using emotions

However, as already mentioned, the main method by which these dementia patients are directed towards musical therapy sessions is with the assistance of a third party. Given their current emotional condition, these people cannot be made open to more precise or successful therapy sessions, Figure 1.2 depicts it too. Some people have remarked that it is not always effective to direct dementia patients to necessary music therapy sessions when a third party is involved. They have stated that the current mood these individuals are in is particularly important when it comes to these sessions, and these caregivers/family members will not always be able to discern it accurately and these people to help with cannot be around all the time. So, it emphasizes that, a smart assistant is very important for a dementia individual when it comes to conducting music therapy sessions.

According to the data gathered by the survey, the pie chart in Figure 1.3 shows that the majority of respondents believe using an assistive tool makes it easier for a person with dementia to be directed to the right music therapy sessions according to their emotions to improve their quality of life and independence, while the least amount of respondents' support receiving assistance from a third party.

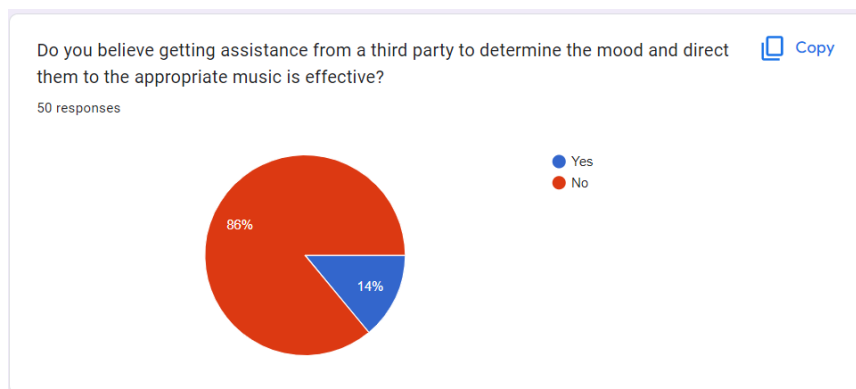


Figure 1.2 – Survey results on the effectiveness of a Third party

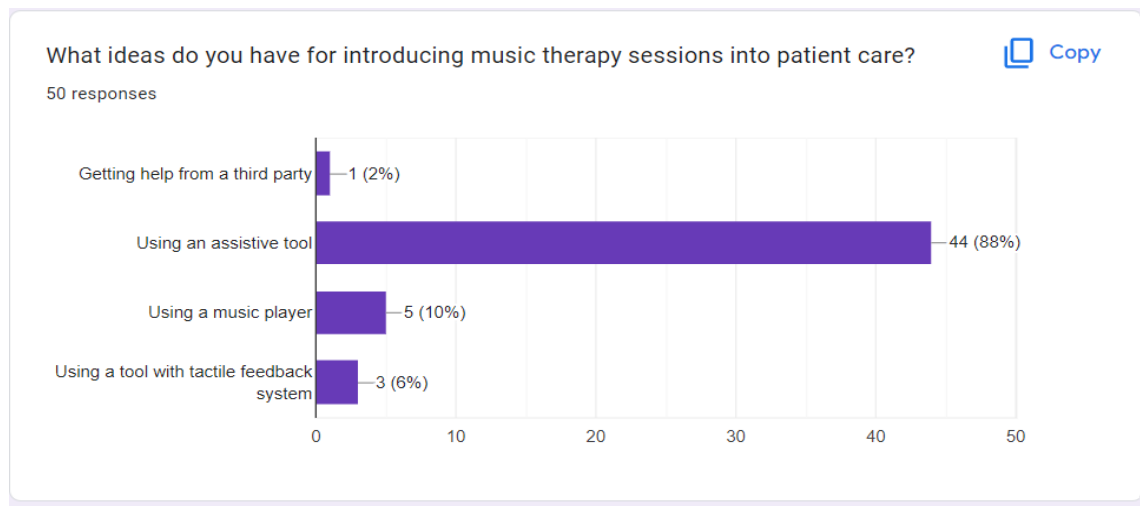


Figure 1.3 – Survey results on the suggestions for dementia individuals to introduce Music therapy

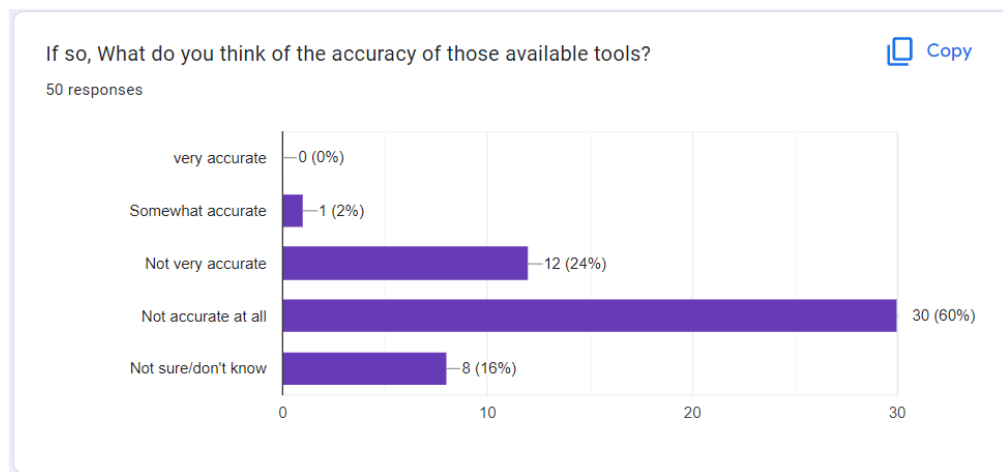


Figure 1.4 – Survey results on accuracy of the available tools

Moreover, technical improvements have made it possible to recognize emotions and predict music in accordance with those using a variety of software and apps. As seen in Figure 1.4 mandatory responses are for low accuracy for existing digital assistants. Many claims that the devices currently available do not accurately detect emotions and are not user-friendly for dementia patients. The literature reviews in article [5] vividly illustrate the operation of similar systems that are already in place, as well as their benefits and drawbacks.

1.2. Research Gap

There are several ways to extract face and audio elements from an audio signal, but very few of the systems created can generate an emotion-based music playlist based on human emotions. This component's main goal is to improve the previous system's weaknesses by creating an automatic emotion-based music generator that creates personalized playlists using user-extractable facial features.

Hafeez Kabani's research project A [5] centered on developing a music player based on human emotions, where the user's image is either captured via a webcam or can be accessed from the stored image on the hard drive. One limitation of this research is that it primarily focuses on Windows programs rather than mobile applications, which will be a more approachable method for addressing individuals. The suggested technique also has a tendency to deliver unpredictable outcomes under very poor camera quality and really poor lighting conditions and is not carried out with a dementia audience in mind. As a result, it is also not user-friendly enough for someone with dementia.

A system called Memory Tracks, an android application that uses music related with daily duties, has been proposed by Stuart Cunningham [6] (Research B) for Dementia patients. With the benefit of song-task association, this program seeks to support daily routines, help with care, help with agitation management, and help trigger memory. Here, instead of considering the patient's emotional state, the appropriate music was selected for each activity from the song library and matched to each resident using their demographic information, such as their birth year and where they spent their childhood.

Based on the documentary Alive Inside, which explores the impact of music on older people's subconscious, Alive Inside [7] (Research C) is a customized music-streaming app for dementia patients. It stands out from other music apps since it gives users a personalized music listening list based on their unique lives to enhance their quality of life. One of this application's biggest flaws is that when creating the user's personalized profile, the developers have not taken their emotional condition into account.

Study D [8] uses Real-time EEG to recognize emotions in music therapy. Here, hardware such as the PET 2 and Emotiv wireless headset were used for gathering the

EEG data. Human computer interfaces may take on a new dimension with real-time EEG-enabled interaction. But, adding further hardware, such as sensors or EEG, tends to raise the price of the suggested design, which can be cited as a drawback.

Pranjul Agrahari came up with a system for musical therapy using facial expressions [9] (Research E) where the features are captured from a web camera and generates a playlist of relevant songs for the patient. One of the major drawbacks of this project is that here a small dataset of songs from a local collection is used which makes the system less accurate. Similar to research A, this method only focuses on a computer-based system and tends to produce unpredictable results in low-quality lighting and camera settings.

As previously noted, numerous methods have been used to anticipate music in accordance with emotional state, however they have significant limitations, such as

- I. For extracting facial features in real time, current methods are quite sophisticated in terms of time and memory needs.
- II. Existing methods are less accurate at creating playlists based on a user's current emotional state and behavior.
- III. Several current systems need additional hardware to generate an automated playlist, which raises the overall cost.
- IV. Several systems now in use produce unpredictable results when subjected to lighting and camera conditions that are both quite poor.
- V. These systems do not focus on keeping the patient engaged throughout these sessions.

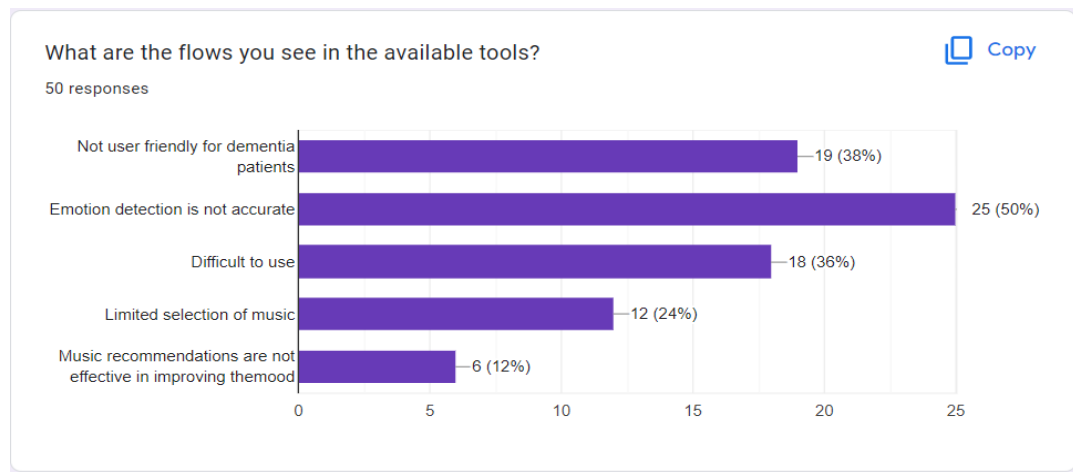


Figure 1.5 – Survey results on flaws in available tools

Also, the majority of survey participants claimed that the current methods do not accurately identify emotions and are difficult for people with dementia to use (Figure 1.5). In consideration of Figure1.6, many people suggest that when creating the new digital assistant, increasing the effectiveness of emotion recognition, offering a wider variety of music, using simple English and UIs will be beneficial.

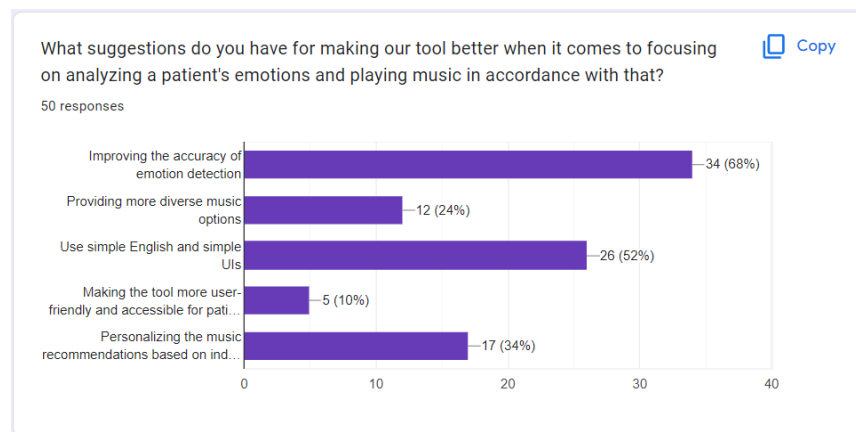


Figure 1.6 – Survey results on the suggestions for a new assistant tool

Table 1.1 – Research gap compared to existing systems

| | Research A | Research B | Research C | Research D | Research E | Our Solution |
|--|---------------|---------------|---------------|---------------|---------------|-----------------|
| Assist Emotion Feature Extraction | Yes | No | No | Yes | Yes | Yes |
| optimized for mobile/ cloud use | No | Yes | Yes | No | No | Yes |
| Detect Age and classify music separately | No | Yes | Yes | No | No | Yes |
| Visual Presentations accordance with the classified Music | No | No | No | No | No | Yes |
| Build A music Library based on real time patient Reaction | No | No | No | No | No | Yes |

Table 1.1 also makes a brief comparison between the suggested solution and the identified problems with the current systems. Reviewing the results reveals that this solution is implemented with far more innovative functionalities than other studies that are currently being done.

1.3. Research Problem

According to the survey conducted, it concludes that it's challenging to forecast these patients' emotional states because they change so frequently. Paper [10] also depicts that dementia increasingly affects memory, reasoning, language, and daily functioning in affected individuals. Dementia frequently accompanies emotional and behavioral issues and can lower a person's quality of life. People with dementia may find it challenging to express themselves verbally as the disease progresses, but even when they are unable to speak, they may still be able to hum or move to the music. Hence, music therapy may be especially beneficial for those who have dementia. Emotional responses frequently vary for people with dementia. They can have less control over how they feel and express themselves. For instance, someone may overreact to situations, experience abrupt mood swings, or feel agitated. They could also come out as abnormally cold or indifferent [11]. Hence as mentioned in paper [5] music may be a means of expression for someone with dementia because it has the ability to convey emotion. As a result of the survey, Figure 1.7 depicts that many people think it is important to identify the emotional state of patients before guiding them to necessary music therapy sessions.

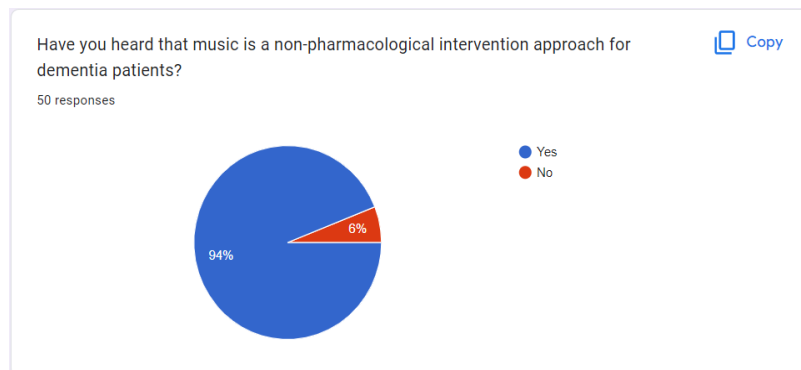


Figure 1.7 – Survey results on the peoples knowledge to the approach on music

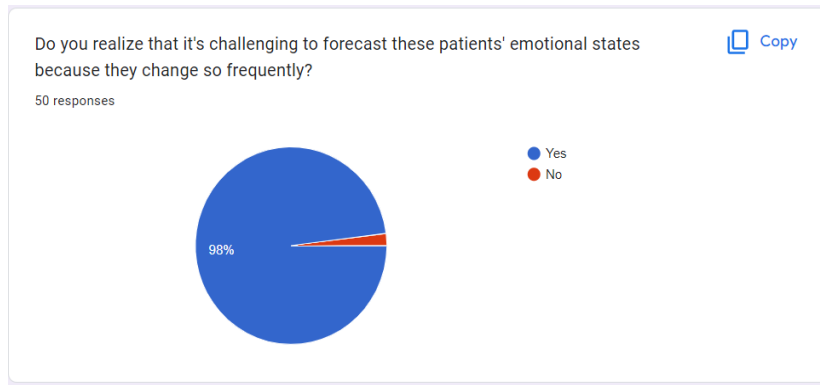


Figure 1.8 – Survey results on the people determine the importance of identifying emotional state

Most people with dementia seek the aid of a third party to ease their daily tasks [2]. According to the survey commentary section and the Figure 1.2, A third party will not be able to effectively identify the patient's emotional condition and direct them to the necessary therapy sessions accordance with those emotions. According to the survey results, Figure 1.6 and literature reviews illustrate accessibility issues with the current tools, lack of understanding, difficulty in usage, a limited range of music, and music recommendations that are ineffective in elevating mood as some other issues.

2. Objectives

2.1. Main Objective

The main goal of assessing a dementia patient's emotional state and making music therapy recommendations in accordance with the emotional state is to enhance that patient's quality of life and lessen behavioral and psychological signs of dementia (BPSD). Agitation, anger, depression, and anxiety are all examples of BPSD, which are prevalent in dementia patients. It has been demonstrated that music therapy helps these symptoms by elevating mood, lowering stress, fostering greater social contact, and enhancing general wellbeing. It is intended that a patient's BPSD may be lessened, resulting in an increase in their quality of life overall, by recognizing their emotional state and offering suitable music therapy.

2.2. Specific Objectives

In addition to the main objectives, there are some specific objectives related to the implementation

- Detecting the face using a face detection model

In order to locate faces correctly algorithms must be created and taught in this manner. These classifiers, which are algorithms, are used for face detection to determine whether a picture contains a face (1) or not (0).

- Collecting facial expression data with the help of an emotion extraction module

To identify the patient's emotional state with a suitable interpretation model, we must first determine the existing emotion extracting models and then propose a new or enhanced emotion identification method. We must gather information regarding a patient's facial expressions, such as the placement of their eyebrows, the contour of their mouth, and the movement of their eyes, in order to ascertain their emotional state. Images that are captured will be recognized as inputs, and the features of the acquired image can be extracted using the new identification model.

- Choosing the appropriate therapeutic music session using an emotion-audio integration module

Provide a music therapy session recommendation module that can reliably identify a patient's emotional condition. Here have to create a database of music therapy sessions that have been proven to be successful in treating particular emotional states in dementia patients by doing research and collecting the data. Based on client feedback and new research findings, continuously update and improve the emotion-audio integration module and music therapy session database. To avoid overstimulating or disturbing the patient, have to make sure the music therapy sessions you choose are appropriate for their cognitive and physical skills.

3. Methodology

The proposed system detects the faces and captures facial expressions of the patient through the front camera. The captured images are then preprocessed to identify facial landmarks, such as the mouth, nose, and eyes. We use these landmarks to extract facial features such as eyebrow movement, mouth curvature, and eye widening. These features are then used to classify the patient's emotional state into basic emotions.

Based on the detected emotion and also taking the patients age in to account, the system recommends appropriate music therapy sessions that have been specifically designed to address the patient's emotional needs. For example, if the patient is detected to be in a sad emotional state, the system will recommend music therapy sessions that have been shown to improve mood and reduce depressive symptoms. When we are considering the emotion detection model, Face detection is one of the applications which is considered. This detection is real-time. And Harr cascade model will be used for that as it is important to have a high level of accuracy in detecting the face. After detecting the face to extract facial features Convolutional Neural Network (CNN) which is used in image recognition and extraction will be used. Music will be selected from an already made music library. And will be played in accordance with the emo0tion which is recognized by the system.

3.1. System Architecture

3.1.1. Software Solution

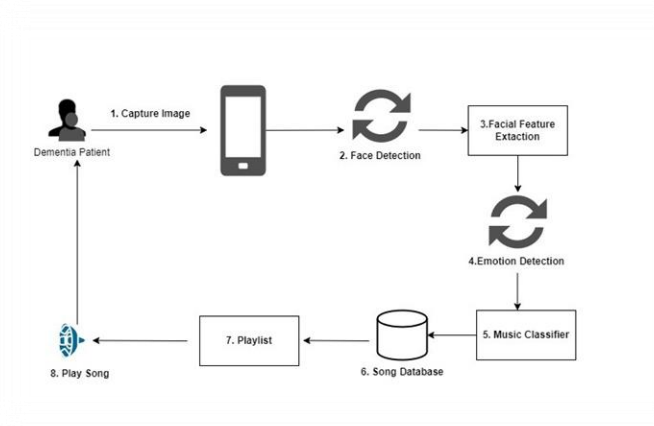


Figure 3.1 – System overview diagram

3.2. The flow of the project

3.2.1. Requirement gathering and analysis

It's essential to ensure that the requirements' gathering process is comprehensive and involves input from stakeholders who will be impacted by the system. Once the requirements are gathered, they need to be prioritized and validated to ensure that the system meets the needs of its stakeholders and achieves its objectives. In summary, the requirements gathering phase is crucial for developing an effective system that meets all the necessary criteria. This phase entails gathering and thoroughly analyzing all of the system's requirements prior to implementation. These requirements can be gathered using a variety of methods, including

- Reading research papers and articles related to musical therapy using emotion recognition.
- Identifying existing tools that are similar.
- Conducting surveys to gather information.

Reading relevant papers can help gain a clear understanding of the requirements while also identifying existing tools and determining gaps that the new component must fill. The survey can also provide useful data and information for developing a competitive

tool that meets the required specifications. It's critical to make sure the requirements gathering process is thorough and includes input from stakeholders who will be impacted by the system. After gathering the requirements, they must be prioritized and validated to ensure that the system meets the needs of its stakeholders and achieves its goals. In conclusion, the requirements gathering phase is critical for creating an effective system that meets all of the required criteria.

3.2.2. Feasibility study

The proposed system's feasibility should be assessed in three key areas.

Schedule Feasibility:

It is critical to ensure on-time completion and a high-quality finished product. To accomplish this, each project phase should be time-bound, with clearly defined timelines and deadlines. To track progress and manage time constraints for each task, a Gantt chart is recommended. The chart can also show potential delays or roadblocks, allowing for quick corrective action.

Technical Feasibility:

Is essential to the success of the project. Members of the research team should be knowledgeable in machine learning techniques for model training and mobile application development technologies. All members should also be knowledgeable in the pertinent computer programming languages. This information is essential for the system's development, design, and implementation because it makes sure the suggested application is both technically sound and effective.

Economy feasibility:

Being economically feasible is essential to the project's success. The project's manpower and resource costs must stay within the allocated budget. This calls for an economical approach to the project without sacrificing the accuracy or thoroughness of the application. This can be done by prioritizing the creation of the system's most important requirements while also taking into account more efficient and affordable options.

3.2.3. Implementation

To develop an app that utilizes emotion recognition to play music, we need to gather relevant information and identify a suitable dataset to train the model. The focus will be on interpreting emotions and selecting appropriate music based on the analysis.

3.2.4. Testing

The product will be tested using different kinds of testing methods such as unit testing, integration testing and user acceptance testing. Because appropriate testing ensures that flaws and issues are found early in the application's life cycle. If there are any issues during the testing phase, these should be addressed before the product is released.

3.3. Project requirements

3.3.1. Functional requirement

- Extract features from the image
- Identify the objects of the image
- Describing the colors of the image
- Describe the main features of the image
- Generate meaningful captions
- Further description of the image using surrounded objects near main subject

3.3.2. Non-functional requirement

- Accuracy
- Availability
- Well optimized for cloud/mobile use

3.3.3. User requirements

- User should have a mobile phone to use the application
- User should have an English knowledge to understand the guidelines
- User should be able to hear
- User should have a simple knowledge to use a mobile application

3.4. Commercialization

To guarantee its efficacy and safety, the commercialization of a mobile app for dementia patients entails numerous regulatory considerations. Clinical trials and regulatory body permissions might be required for the app. Moreover, funding for the creation and promotion of the app could come from sponsorship from governmental organizations, academic institutions, or pharmaceutical firms. To expand the number of prospective users of the app and promote early diagnosis and treatment, it is also crucial to raise awareness of dementia among the general public. Relationships with advocacy groups, professional associations, and healthcare organizations could assist spread information and connect with target audiences. Therefore, the development of a mobile app for dementia patients necessitates a thorough strategy that takes into account legal, financial, and public health considerations.

4. Budget and justification

Table 4.1 – Budget justification

| Item | Cost(RS) |
|---|----------|
| App publishing cost on google play | 5000.00 |
| Backend hosting cost | 10000.00 |
| Manufacturing cost of IoT device and system | 40000.00 |
| Paper publishing cost | 5000.00 |
| Total | 60000.00 |

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5. Appendices

5.1. Gantt chart

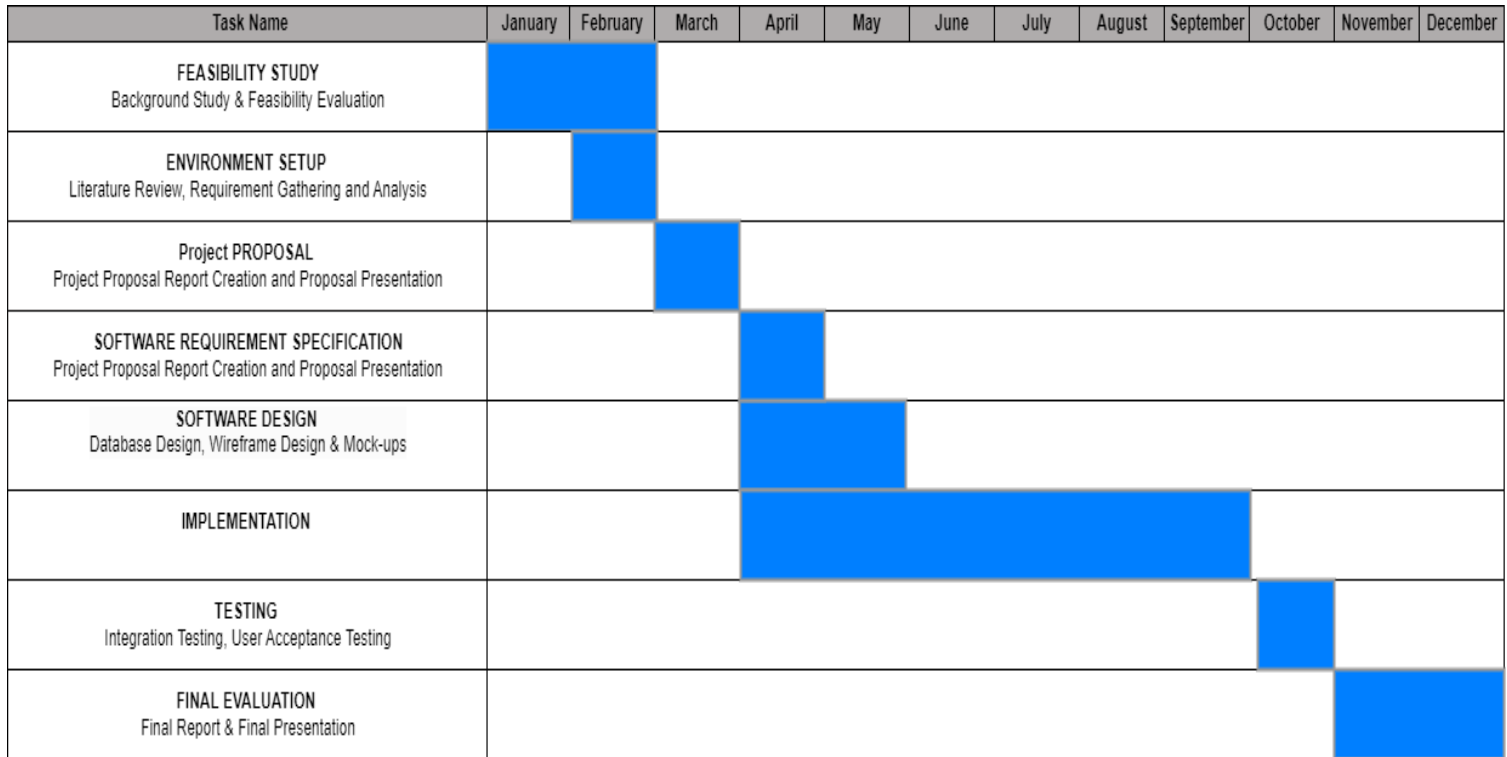


Figure 5.1 – Gantt chart

5.2. Work Breakdown Structure

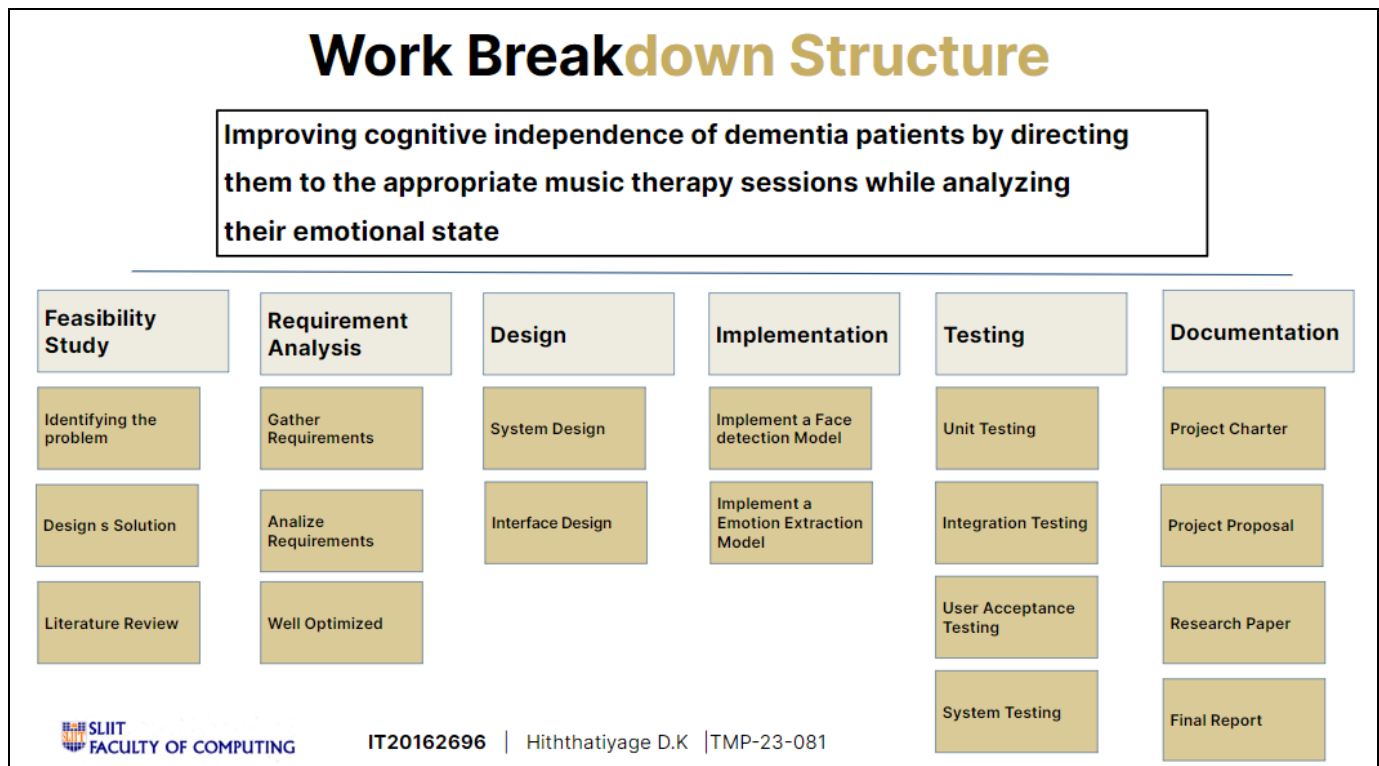


Figure 5.2 – Work Breakdown Structure (WBS)

5.3. Online Survey

Survey conducted in order to get details on developing a mobile app for dementia patients.

Dear Respondent,

I'm a Final year student from the department of computer science and software engineering, faculty of computing , SLIIT

I'm researching dementia patients to identify their emotions and create music therapy sessions for them in accordance with those emotions.. This survey is conducted to gather some data required to proceed with the research.

 **udzhiththatiyage@gmail.com** (not shared) [Switch account](#)



* Required

Gender *

☐ Female

☐ Male

☐ Other: _____

Age *

Age *

- ☐ Below 18
- ☐ 18-25
- ☐ 26-30
- ☐ 31-40
- ☐ 41-60
- ☐ Above 60

Have you heard about Dementia *

- ☐ Yes
- ☐ No

Have you ever associated a Dementia Patient *

- ☐ Yes
- ☐ No
- ☐ Maybe

How often do you listen to music? *

- ☐ Everyday
- ☐ Few times a week
- ☐ Once a Week
- ☐ A few times a month
- ☐ Rarely or never

Have you heard that music is a non-pharmacological intervention approach for dementia patients? *

- ☐ Yes
- ☐ No

Do you realize that it's challenging to forecast these patients' emotional states because they change so frequently? *

- ☐ Yes
- ☐ No

What ideas do you have for introducing music therapy sessions into patient care? *

- ☐ Getting help from a third party
- ☐ Using an assistive tool
- ☐ Using a music player
- ☐ Using a tool with tactile feedback system

Do you believe getting assistance from a third party to determine the mood and direct them to the appropriate music is effective? *

- ☐ Yes
- ☐ No

Do you believe a digital assistant is required to anticipate patients' emotional states and suggest music to them based on those moods? *

- ☐ Yes
- ☐ No

Have you heard of any such tools existing dementia patients? *

- ☐ Yes
- ☐ No

If so, What do you think of the accuracy of those available tools?

- ☐ very accurate
- ☐ Somewhat accurate
- ☐ Not very accurate
- ☐ Not accurate at all
- ☐ Not sure/don't know

What are the flows you see in the available tools?

- ☐ Not user friendly for dementia patients
- ☐ Emotion detection is not accurate
- ☐ Difficult to use
- ☐ Limited selection of music
- ☐ Music recommendations are not effective in improving themood

What suggestions do you have for making our tool better when it comes to focusing on analyzing a patient's emotions and playing music in accordance with that? *

- ☐ Improving the accuracy of emotion detection
- ☐ Providing more diverse music options
- ☐ Use simple English and simple UIs
- ☐ Making the tool more user-friendly and accessible for patients with varying levels of cognitive ability.
- ☐ Personalizing the music recommendations based on individual age

Submit

Clear form

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5.4. Plagiarism Report

The screenshot displays the Turnitin interface. At the top, there's a navigation bar with links like 'Class Portfolio', 'My Grades', 'Discussion', and 'Calendar'. Below this, a message box welcomes the user to the class homepage. The main content area is titled 'Class Homepage' and contains a table of assignments. The table has columns for 'Assignment Title', 'Info', 'Dates', 'Similarity', and 'Actions'. One assignment is listed: 'Project Proposal Report'. It shows a similarity score of 8% and a green bar. The 'Dates' column shows 'Start: 02-Mar-2023 6:22PM', 'Due: 31-May-2023 11:59PM', and 'Post: 10-Mar-2023 12:00AM'. The 'Actions' column has buttons for 'Resubmit', 'View', and a download icon.

| Assignment Title | Info | Dates | Similarity | Actions |
|-------------------------|------|--|------------|---|
| Project Proposal Report | | Start: 02-Mar-2023 6:22PM Due: 31-May-2023 11:59PM Post: 10-Mar-2023 12:00AM | 8% | Resubmit View |